PROCESS INNOVATION OPPORTUNITIES FOR RESEARCH & DEVELOPMENT MANAGEMENT - A STUDY OF INDIAN BIOTECHNOLOGY SECTOR

SHORT SYNOPSIS

Submitted in fulfillment of the requirement of the degree of

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Certificate

I hereby declare that the short synopsis 'PROCESS INNOVATION OPPORTUNITIES FOR RESEARCH & DEVELOPEMENT MANAGEMENT - A STUDY OF INDIAN BIOTECHNOLOGY SECTOR' being submitted in partial fulfillment of the requirement for the degree of Doctor of Philosophy in Management under Faculty of Management Studies of Manav Rachna International Institute of Research & Studies, Faridabad during the academic year 2018-19. It is a bona fide record of original work carried out under the supervision of Dr. Sonal Pathak and has not been submitted in full or part to any other university or institute for degree or diploma. Further, it is certified that short synopsis is plagiarism free and proof has been submitted.

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ABSTRACT

Biotechnology research is majorly transdisciplinary in nature which involves multiple stakeholders with complex interdependent processes. In Biotechnology Research & Development Organizations, knowledge-intensive research work and product innovations are primarily managed by scientists and research scholars. Recently in several media reports, it was reported how scientists and scholars are facing multiple challenges like delay in funding and salary, complex process of industry collaboration, proper management support, etc.

To stay competitive, nowadays various organizations continually attempting to find methods to become more efficient. In the knowledge-intensive Research & Development organizations, major focus is on product innovation. But it is a well-known fact that process innovation also leads to organizational efficiency and many organizations adapting 'process innovation' approaches for it. But when Research & Development organizations were considered, there is a lack of literature regarding whether they are adapting Process innovation approaches or not. In this study, the author is willing to find out the perception of stakeholders on current challenges faced in the research ecosystem and opportunities to solve these challenges by adapting process innovation approaches in Research & Development management practices in the Biotechnology Research & Development organizations in India. The study will develop a framework for process innovation for Research & Development management at Biotechnology Research & Development Organizations, which will help management, leadership, and policymakers to improve organizational efficiency.

Keywords: Biotechnology, Research & Development Management, Organizational efficiency, Process Innovation

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1. INTRODUCTION

1.1. Biotechnology

Biotechnology is technology based on biology which makes use of any organisms or their parts to modify or make products, or improve animals, plants and microorganisms. It encompasses various subjects like medical biotechnology, microbial biotechnology, plant biotechnology, animal biotechnology, environmental biotechnology, aquatic biotechnology and forensic biotechnology. As Biotechnology and Biotechnology based Research & Development (R&D) organizations and bio-industries are linked to development in life-sciences and technologies based on them, they are now considered a vital section of the knowledge-based economy. (Chekol, 2018). Biotechnology has various applications in drug development, disease diagnostics, agriculture, animal husbandry, environmental management, waste treatment, and ecological conservation etc. (IBEF Report, 2014)

1.2. Biotechnology in India

Biotechnology is slowly emerging high potential sector which is growing in India and has the potential to take India into the next big league of internal and international investment. The twelfth five year plan of Government of India is aiming to improve the pace of R&D and innovation to make further progress of biotechnology in India. Yet India's complicated regulatory system along with bureaucratic structure and redundant processes delay the overall process at Government's end also at the Organizational level which is blocking the sector's growth.

1.3. Research & Development (R&D) Management

Cook (1969) defined research management as Research Management consists of the application of both management and management sciences to the field of research and development activities in an area. According to Akhilesh (2014), Research & Development (R&D) management is a combined task of management of innovation (i.e., creating and commercializing inventions) & the management of technology (i.e., the internal & external creation and retention of technological know-how). It comprises different processes such as basic research or fundamental research, technology development, development of new process or product, technology transfer etc. But few processes are not included in R&D management, which is independent like intellectual property, incubation, corporate venturing. Functional aspects of R&D functional processes like human resource, finance, production, and marketing.

Hence it is clear that Research Management is the area of management where personnel (usually called a research manager) or an office (may be called as Research management office) comprising of group personnel manages various operational and administrative processes related to research. It comprises of pre-research grant and post-research grant management, project management, collaboration as well as stakeholder management, laboratory management, Communication management, and can include any processes related to procuring equipment and consumables, managing vendors, managing business development, outreach activities, transfer of technology & knowledge management.

1.4. Innovation

The subject of 'Innovation' is widely explored in the last decade and a large body of research was generated on innovation, technological innovation as well as management and organizational innovation (Szabo and Csontos, 2016). Innovation is the new creations of economic significance created by organizations. It may be product innovation or process innovation (Figure 01). In the literature of innovation, it has been commonly conceptualized as a phenomenon that is technology oriented. Regardless of this, researchers currently considering innovation as a broad phenomenon, which is based on both technology as well as management or organizational innovation i.e. the introduction of new management practices. (Cassiman and Veugelers, 2004); (Hervas - Oliver, Albors Garrigos, and Gil -Pechuan, 2011).

Types of Innovations			
Product Innovation		**Process Innovation**	
In goods	In services	Technological	Organizational

Figure. 01. Types of Innovation

Source: Hage, 2006

1.5. Organizational Innovation

Researchers also studied that to achieve the desired efficiency growth, before technological innovation, management innovation must take place, which is a form of organizational innovation. (Szabo, R. & Csontos, R., 2016). Management innovation is popularly known as organizational innovation, managerial innovation, or administrative innovation. These are usually non-technological in nature. There are different than product innovation. Rather it includes process innovation like introducing new management practices, new organizational structures, new administrative systems, etc. (Damanpour, 2014)

1.6. Process Innovation

Process innovation is a management innovation phenomenon. It is the advanced way of performing and managing tasks across the entire supply chain to enhance efficiency in operations & services, improve quality & performance and reducing cost. Generally, process innovation is internal to the customers in nature, process innovations do not just serve to a goal, and rather it serves as a means for achieving a performance of higher-level. (Jin, Cedrola and Kim, 2019). This important strategy is neglected because the major focus on product development, but process innovation also develops and strengthens an organization's competitive advantage. (Oliver, 2012)

1.7. Process Innovation Tools

The various tools of process innovations are information system (IS), digital technology (DT), robotics and artificial intelligence (AI). This helps to enhance the efficiency of the supply chain, to obtain data in real-time mode, to optimize deliveries, and to reduce turnaround time of production and service. But these systems and technologies are not the only tools for Process innovation. Without these tools also employing other management innovation practices, organizations can achieve process innovation. Organizations need to find out the key problem areas and try to modify or reengineer the processes either in an incremental way or through radical innovation, by using or not using the technologies, based on their existing systems. (Jin, Cedrola and Kim, 2019)

1.8. Product Innovation Vs Process Innovation

A 'novel product' is the major objective in product innovation. A new or novel product becomes a key differentiator of the organization compared to its competitors. Organizations try to make a superior product with respect to price and quality by doing Product Innovation. But in process innovation, the major focus is not to create a novel 'process' rather create efficiency in the existing process (Hatch and Mowery, 1998; Ettlie and Reza, 1992).

1.9. Process Innovation in Research & Development Management

Research is essentially creative and uncertain in nature. Due to various reasons, the course the research takes any unpredictable turn. A Principal Investigator's (PI's) major task is to run the lab smoothly without any hindrance and motivate and support whole lab members for the highest degree of creativity and innovation. Few have come with this inborn talent manage things and

others get trained on the job, few never able to manage the research labs efficiently which brings the scientist in a situation of a disadvantage. (Portny and Austin, 2002).

Through R&D Organization s focus more on product innovations, it is also important to understand, how they improve their internal processes to improve the organization's operational efficiency.

2. LITERATURE REVIEW

2.1. Indian Biotechnology Sector

The Biotechnology sector in India is a knowledge-based sectors which is growing at a rapid speed. It is predicted that this sector will play a major role in India's growing economy. Because of the existing Research & Development (R&D) infrastructure, human resources, cost-effectiveness, the biotechnology industry of India will emanate as a global player.

In India, the biotechnology sector can be divided into various segments as described in figure 02.

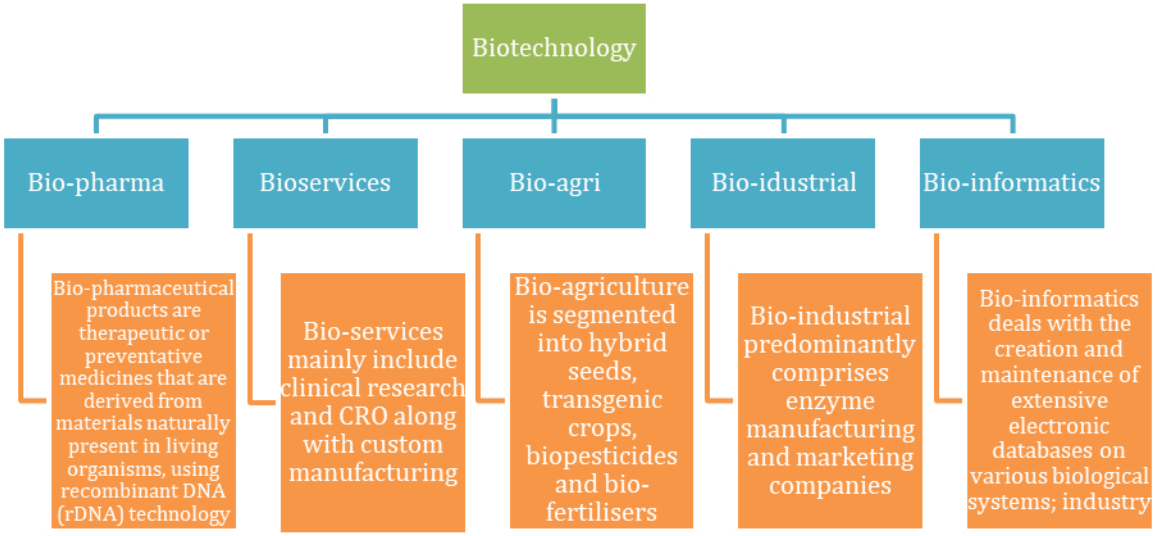
Biotechnology
Bio-pharma
Bioservices
Bio-agri
Bio-idustrial
Bio-informatics
Bio-pharmaceutical products are therapeutic or preventative medicines that are derived from materials naturally present in living organisms, using recombinant DNA (rDNA) technology
Bio-services mainly include clinical research and CRO along with custom manufacturing
Bio-agriculture is segmented into hybrid seeds, transgenic crops, biopesticides and bio-fertilisers
Bio-industrial predominantly comprises enzyme manufacturing and marketing companies
Bio-informatics deals with the creation and maintenance of extensive electronic databases on various biological systems; industry

Figure 02: Segments of Biotechnology

Source: ABLE – Biospectrum Survey, June 2013; TechSci Research

The Department of Biotechnology (DBT) is being set up by the Government of India in 1986. India's Biotechnology industry is growing at Compound annual growth rate of nearly 20% in the last 10 years because of the Government's support. To grow further R&D infrastructure needs to be improved, collaboration needs to be improved and supported, and best in class regulatory policies need to be framed by the Government.

Though India has so many research institutes and it requires trained manpower to manage research activities, in India management courses in R&D management discipline are rare, whereas it is a major management area in western countries. Though few institutes provide a refresher course on R&D management for few days or maximum up to a week; it may not suffice the greater requirement of training a vast amount of R&D management aspirants

2.2. Research & Development Organizations in India

Research & Development has bigger role to play in India's competitiveness in terms of science and technology. Department of Science and Technology (DST), Govt. of India defines 'Research & Development (R&D) institution' as either a research institute or a national laboratory or a research station or in-house R&D unit of private and public sector or a not for profit Scientific and Industrial Research Organization (SIRO) or an academic institution. These organizations are not similar and are of different structures in terms of resources and funding patterns (DST, 2018).

Various agencies like Indian Council of Agricultural Research (ICAR), Indian Council of Medical Research (ICMR), Department of Science and Technology (DST), Council of Scientific and Industrial Research (CSIR) , Department of Biotechnology (DBT) supports various R&D institutes by means of funding, infrastructure and manpower support. These agencies also support the management of research and monitor the progress. Various public sector organizations are also involved in Biotechnology research.

According to the Directory of R&D institutions (2018) published by the Department of Science and Technology, Government of India (Eleventh Edition), R&D Institutions are categorized as per Table 01.

Table 01: Categories of Research & Development Institutions in India

Category	Details
1. Central Government R&D institutions	These institutions are divided into three broad groups viz. (a) Major Scientific Central Government Ministries/Departments/Agencies (b) Other Central Government Ministries / Departments (c) Central Government Public Sector in-house R&D units.
2. State Sector	These institutions are divided into four broad groups viz. (a) Agricultural universities within the State (b) Research Stations within the State and (c) State Government R&D institutions (d) State Public Sector industries
3. Academic Sector	(a) Higher Education Sector - Central, State, Deemed, Private universities with S&T faculty, and State Agriculture Universities (b) Institutions of national importance
4. Scientific and Industrial Research Organisations	Scientific and Industrial Research Organisations (SIRO's) recognized by Department of Scientific and Industrial Research (DSIR)
5. Private Sector Industries	(a) In- house R&D units of private sector industry recognised by Department of Scientific and Industrial Research (DSIR) (b) Industries performing R&D but not registered with DSIR. (i.e. listed in Central Monitoring of Indian Economy (CMIE) database)

Source: Directory of R&D institutions (2018) published by the DST, Govt. of India

The Directory contains details of 6862 R&D institutions in the Country. The share of various sectors is given in Figure. 03. As of April 2015, employees employed in the R&D organizations

in India is approximately 5.3 lakhs. 3 lakhs (54%) were performing R&D and 1.3 lakhs (24%) are auxiliary staff and 1.2 lakhs (22%) administrative / non-technical support staff.

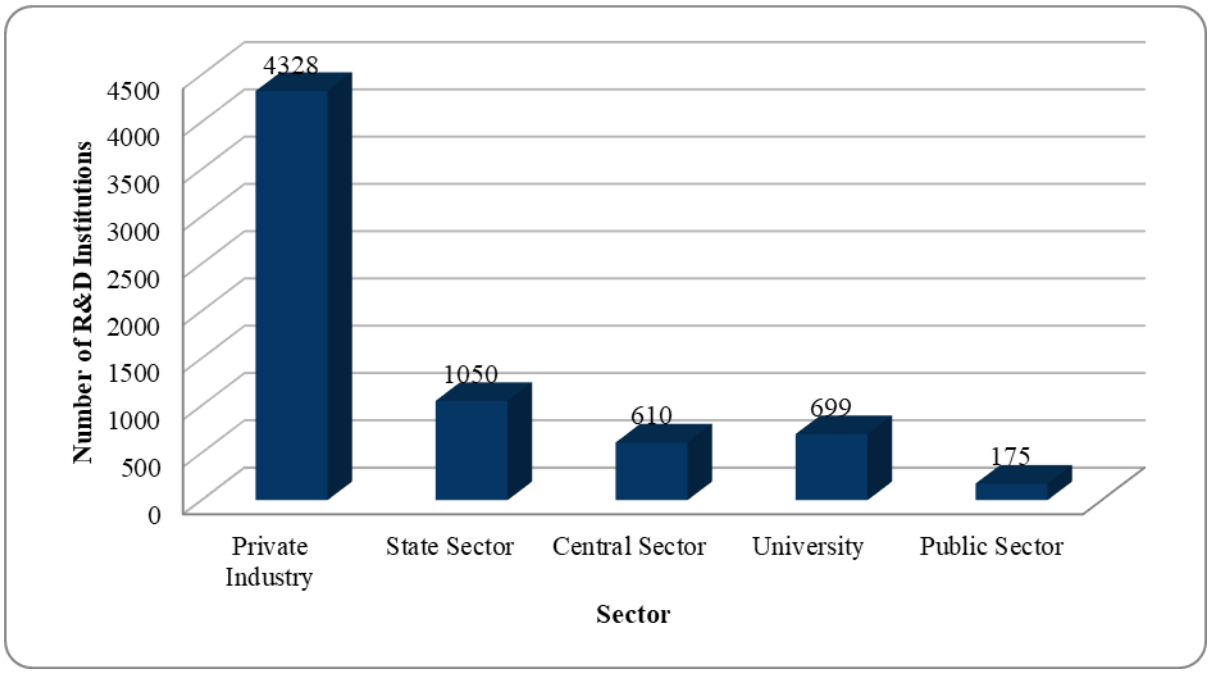

Figure: 03 - Distribution of Research & Development Institution by Sector.

Source: Directory of R&D institutions (2018) published by the DST, Govt. of India

2.3. Research & Development Processes and Its Management

Nobelius, D. (2002) in his doctoral thesis explored the R&D process management with respect to technology and product development, and their interaction. He explained that two domains one needs to address, one is to manage internal organizational processes interfaces and the other is to manage technology & product development. The study was conducted to understand the processes involved in the management of R&D in manufacturing firms.

Dhawan (2002) explained that the management of units handling routine work and the management of units handling R&D work must be different as the processes are unique, ambiguous, and inherently uncertain in R&D Units.

Portny and Austin, (2002) have explained how small labs have to manage the processes of fund flow, managing human resources, procuring and maintaining the required set-ups, managing different shareholders like organizations, host institutions, funding bodies, and so on. He stressed on the importance of managing the processes during the time of seeking a grant renewal--or tenure.

2.4. Process Innovation in Research & Development Organization

Jin (2019) has examined the process innovations in the fashion industry in five areas such as production, store operations, order management, product development and services. The authors emphasized the necessity of continuous process innovation to achieve success with respect to fashion firms.

Hervas-Oliver (2014) has examined process innovation as a growth strategy for SMEs in Spain. SMEs adopting process innovation strategy depend on external sources for knowledge acquisition to support internal innovation.

Lund, K. (2012) has explained in the R&D organization, how the creativity of the people gets influenced by the use of process management. He showed a positive relationship between creativity and process management.

Lee (2018) have suggested that formal training in management and strategies are imparted on scientists and they find leadership positions difficult. So the Scientist training process may be a parameter for process innovation.

2.5. Research & Development Management in India

Earlier scholars have studied different facets of R&D management in India. The summary of relevant research works is given below in Table 2.

Table 02: Research & Development Management Research in India

Authors	Year	Topic
Rahman	1976	Planning of R&D
Valluri	1976	Developing priorities in R&D
Dhawan	1985	Aspects of Training in the management of R&D
Dhawan and Roy	1993	Job facets of Indian Scientists
Reddy	1997	Trends in globalization of corporate R&D and implications for innovation capability
Dhawan	1999, 2001	Job Satisfaction in R&D organizations
Roy and Nagpal	2001	Development of a measurement model of the effectiveness of research units
Dhawan, Roy & Kumar	2002	Organizational energy – people-oriented approach-for diagnosing the level of satisfaction of scientists working in R&D laboratories
Jyoti, Banwet, & Deshmukh	2010	Modeling the success factors for national R&D organizations

Source: Self-created

In February 2018, Wellcome Trust/ DBT India Alliance initiated the India Research Management Initiative (IRMI) for strengthening research management at institutions in India.

(National Centre for Biological Sciences (NCBS) Newsletter, August 2018). The mandate of IRMI is to provide opportunities for research managers in India to receive mentorship, training, career development, and networking opportunities. To spread awareness of India, IRMI has been organizing small workshops across India.

2.6. Research & Development Challenges in India

In an article 'Bureaucracy is a hindrance to scientific progress' published in India Today (2014), Bharat Ratna Prof CNR Rao pointed out that, Scientific progress of India is hindered by bureaucracy. Scientific Organization s are governed by the same rules applied in non-scientific offices. Appointments are delayed. Restrictions of age and experience are applicable for appointments. He pointed out how a brilliant scientist with 9.5 years of experience can be denied a position that requires 10 years of job experience. He also emphasized how India still have old regulations that are hampering the progress of science. He also compared the tenure of Indian projects with that of the European Union. In India, research projects are funded for 3 years whereas in European Union grants were given for 5 to 10 years. A scientist can come up with better results if the time span of the projects is higher. He emphasized a complete reformation of existing rules which are bureaucratic in nature and outdated with respect to the modern world. (India Today, 2014)

In an article "Of all scientific fields, medical research gets much less funding", published in Live Mint (2019), Dr.Gagandeep Kang**,** Director of Translational Health Science Technology Institute (THSTI), Faridabad mentioned that; *"In India does not has ways of retaining outstanding talent, and has a few systems of reward, particularly within government ecosystems*". She pointed out, *"I do not think we realize how quickly the fields of medicine are changing with new technologies and how rapidly we are being left behind. The current system of requiring a minimum number of publications and time as the only objective measures of academic promotion in medical colleges is leading to high numbers but low quality work. I am concerned that this poor quality of research will become the benchmark."* (Live Mint, 2019)

2.7. Gaps in Existing Studies

1. In India, there are different types of Research organization. The main role and core activities of Research & Development organization are knowledge creation, product development and innovation and the essential component of the modern knowledge economy. But while doing innovation in products, technology, R&D Organizations also faces challenges in terms of administrative, operational and management. These

challenges need to be explored.

2. The key to solving these R&D management challenges are, the Research Offices should also focus on existing processes, finding the gaps, developing new processes. i.e. innovate processes to improve organizational efficiency. How the organizations are improving these processes that need to be explored.
3. Scientists and researchers of these organizations require access to professional research management support, so that they can resource efficiently and do seamless collaborative work. Meanwhile, significant gaps are observed in the research management support at the R&D Organizations which in turn interfere in Organization efficiency and in the research ecosystem in India.
4. There is a need to analyze, how the research and its support activities are managed and how the whole research management ecosystem functions in India. Through media reports where scientists suggest may challenge; a systematic perception study is unavailable, which can throw light on the management practices in India R&D Organizations and the available policy for research management. Hence, there is a requirement of a systematic study, which will throw light on process innovation needs of Indian R&D Organizations.
5. Process innovation opportunities in the R&D organization are less explored by R&D management or innovation scholars. In the Indian context, it is yet to understand how different R&D organizations improve their process and what is their perception of Process Innovation.
6. The detailed practices adopted by Research offices for Process innovation have not been systematically mapped out. Many authors have written about the important project management skills, techniques, and practices in research centers, but few have explored how to change existing processes and how to innovate in processes of the R&D organization.
7. DST, 2018 report suggested around 46% (around 2.5 lakhs) were engaged in support activities (administrative, non-technical and auxiliary). It is generally observed that among these support staff, very few percentages of people may have few years of specific R&D management experience before they initiate their career but in most cases, this personnel are generally trained on the job by peers. Thus, how to develop human resources for managing scientific research is a great concern, which needs to be addressed.

3. DESCRIPTION OF BROAD AREA

The broad area of the study is Research and Development (R&D) Management, also referred as Research Management. To study Research and Development Management practices, its challenges and to overcome those challenges how organizations carrying out 'process innovation' activities to improve organizational efficiency, the Biotechnology research organizations are selected.

Biotechnology Research and Development organizations are quite complex in nature and involve in managing huge collaborative projects and programs which need better standard operational procedures, project management practice for better results. Management of research and development in biotechnology R&D laboratories within a knowledge-intensive, highly regulated ecosystem creates so many challenges with respect to practices, people, and processes. Hence, organizations must be adopting some strategy to innovate in processes. As there is less studies around the process innovation especially in R&D Management and there is no framework for process innovation, which organizations will employ to gain better organizational efficiency, author is motivated to study about this topic. The study will involve identifying the typology and dynamics of Research offices and exploring Process innovation activities in the R&D Organizations within the Biotechnology sector. This study will focus on how processes are different in different R&D Organizations, How R&D organizations innovate its processes, what challenges organizations face while doing process innovation, what are the perception of both external and internal stakeholders of the R&D organization towards 'Need of Process Innovation in R&D management' etc. Considering all these questions, the study will find out what the possible process innovation opportunities in the Biotechnology R&D Organizations.

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4. OBJECTIVES OF THE STUDY

The objectives of the study are:

(1) To study the challenges involved in R&D Management practices in Biotechnology R&D Organizations in India

(2) To study perception of stakeholders towards the requirement of process innovation in R&D Organizations and to explore the opportunities for improving R&D Management processes in in Biotechnology R&D Organizations in India

(3) To develop a framework of process innovation in R&D Management practices in Indian R&D Organizations.

5. METHODOLOGY

5.1. Research Design

In this study, both exploratory, as well as a descriptive research technique, will be used to gain the background information and recent process-related challenges faced by internal and external stakeholders of Biotechnology R&D organizations. Both secondary as well as primary data, will be used to conduct exploratory research.

5.2. Data Collection

Primary data shall be collected through a structured questionnaire. The on-line survey research method will be used to collect the data for cross-sectional analysis at a faster rate. The exploratory research approach will be used for primary data collection through a multi-level case study (observation, analysis of the documents, and conducting interviews).
Secondary data shall be collected from the Literature Review, by collecting data from published journal articles, review papers, research work, magazines, etc.

5.3. Questionnaire

Based on our objectives, questionnaire will be developed to assess both internal and external stakeholder's perceptions of opportunities for Process innovation in R&D Management. Each participant will be informed regarding the study and those who are willing to participate will fill the questionnaire.

5.4. Sample Selection

Multi-stage stratified random sampling and convenient sampling techniques will be used to collect the samples. The study will not be limited to a particular city but will be targeted to major R&D organizations working on the Biotechnology discipline in India by an online survey. However, the majority of work shall be carried out in the National Capital Territory of Delhi. The sample size would be 300 individuals.

5.5. Sample Distribution:

The following sample distribution will be followed.

Table 03: Sample Distribution

R&D Organization Types
1. Public sector R&D institutions
2. Private Sector Industries
3. Public sector academic organization/universities
4. Private sector academic organization/universities

Stakeholders
1. Scientists and Researchers a. Young scientists, (who are recently started their career) b. Mid-career Scientist c. Scientist joined an Indian R&D lab after from working abroad d. Retired Scientists e. Ph.D researchers
2. Support Staffs a. R&D Managers b. Project Officers / Project Managers c. Technical officers/section officers/support staffs d. Administrative staffs
3. Research Scholar
4. External Stakeholders a. Advisors and b. Vendors and Suppliers c. Career Aspirants (Scientist, Support Staff, Scholar) d. Parents

Source: Self-created

Inclusion Criteria: Samples with a minimum of 1 year of working experience in Biotechnology R&D Organizations in their respective functions will be selected.

Exclusion Criteria: Samples with less than 1 year of working experience or no exposure to Biotechnology R&D Organizations will be excluded.

5.6. Data Analysis

The data collected from respondents will be analyzed through the latest version of SPSS package. To compare the data, different descriptive statistical methods will be used involving collection, summary and presentation of the data. Suitable parametric techniques will be used to analyze the data. Result findings will be added into the thesis to make conclusion of the research and to give the suggestive outcome.

6. EXPECTED OUTCOME OF THE RESEARCH

1. The study will extend the theoretical contribution in Research Management and Process Innovation literature, highlighting the requirement of process innovation in R&D management with respect to Biotechnology research.
2. The study will explore to Identify major challenges in the implementation of the research project management system at the institutional level.
3. The study will highlight the stakeholder's perception towards common challenges in R&D management and how the organizations improving its existing processes of managing research. The study will also highlight the stakeholder's perception towards implementing process innovation approaches to improve R&D management practices and in turn organizational efficiency. The study will explore the opportunities for improving R&D Management processes in Indian R&D Organizations
4. The study will explore the need for well-trained Research managers and modern R&D management setups and the need of modern project management tools to improve the project operation and delivery.
5. The study will develop a framework for process innovation at Biotechnology R&D organizations in India

7. REFERENCES

Akhilesh, K. B. (2014). *R&D Management*. Springer.

Carter, I., & Langley, D. (2009). Overview of research management and administration. *Perspectives: Policy and Practice in Higher Education*, *13*(2), 31–32. https://doi.org/10.1080/13603100902805359

Cassiman, B., & Veugelers, R. (2002). R&D Cooperation and Spillovers: Some Empirical Evidence from Belgium. *The American Economic Review*, *92*(4), 1169–1184. https://doi.org/10.2307/3083305

Chekol, C., & Gebreyohannes, M. (2018). Application and Current Trends of Biotechnology: a Brief Review. *Austin Journal of Biotechnology and Bioengineering*, 5(1), 1088

Cook, D. L. (1969). Research Management--Of What Nature Is the Concept?, 1969-May-23. Ohio State University, Columbus. Educational Program Management Center. Retrieved from https://eric.ed.gov/?id=ED031786

Damanpour, F. (2014). Footnotes to Research on Management Innovation. *Organization Studies*, *35*(9), 1265–1285. https://doi.org/10.1177/0170840614539312

Dhawan, S.K. (1985). Research and development. *Training and Development: a Sectoral Analysis.* Indian Society for Training and Development, Delhi, pp. 79 – 92.

Dhawan, S.K. and Roy, S. (1993) Scientists and their job: a case study from India. *Productivity*, 33, 4, 650– 655.

Dhawan, S.K. (1999). Job satisfaction among Indian scientists: some empirical findings from a research laboratory. *Journal of Scientific and Industrial Research*, 58, 96 – 106.

Dhawan, S.K. (2001). Variations in job satisfaction with age: some empirical findings. *Productivity*, 42, 1, 151 – 155

Dhawan, S. K., Roy, S. and Kumar, S. (2002). Organizational energy: an empirical study in Indian R&D laboratories, *R and D Management*, 32(5). doi: 10.1111/1467-9310.00271.

Directory of R&D institutions (2018). published by the Department of Science and Technology, Government of India (ISBN-81-87607-32-7 Eleventh Edition)

Ettlie, J. E., & Reza, E. M. (1992). Organizational integration and process innovation. *Academy of Management Journal*, *35*(4), 795-827.

Hage, J. (eds) (2006). *Innovation, Science, and Institutional Change: A Research Handbook.* Oxford University Press.

Hatch, N. W., & Mowery, D. C. (1998). Process Innovation and Learning by Doing in

Semiconductor Manufacturing, *Management Science*, vol. 44, issue 11-Part-1, 1461-1477

Hervas-Oliver, J.-L., Albors Garrigos, J. and Gil-Pechuan, I. (2011). Making sense of innovation by R&D and non-R&D innovators in low technology contexts: A forgotten lesson for policymakers, *Technovation*, 31(9). doi: 10.1016/j.technovation.2011.06.006.

Hervás Oliver, José Luis, Sempere-Ripoll, Francisca and Boronat-Moll, Carles (2012). Process innovation objectives and management complementarities: patterns, drivers, co-adoption and performance effects. *UNU-MERIT*.

Hervas-Oliver, J.-L., Sempere-Ripoll, F. and Boronat-Moll, C. (2014). Process innovation strategy in SMEs, organizational innovation and performance: a misleading debate?, *Small Business Economics*, 43(4). doi: 10.1007/s11187-014-9567-3.

India Today, (2014). *Bureaucracy is a hindrance to scientific progress, says Bharat Ratna CNR Rao,* Retrived from https://www.indiatoday.in/india/story/cnr-rao-bharat-ratna-exlcuive-interview-179671-2014-02-04

India Brand Equity Foundation (IBEF) Report, (2014). Retrieved from https://www.ibef.org/industry/biotechnology-india.aspx

Jin, B. E., Cedrola, E. and Kim, N. (Lauren) (2019). Process Innovation: Hidden Secret to Success and Efficiency, *Process Innovation in the Global Fashion Industry. Palgrave Studies in Practice: Global Fashion Brand Management.* Palgrave Pivot, New York, pp. 1–23.

Jyoti, Banwet, D. and Deshmukh, S. (2010). Modelling the success factors for national R&D organizations: a case of India, Journal of Modelling in Management, Vol. 5 No. 2, pp. 158-175.

Lee, G. (2018). Training scientists as future industry leaders: teaching translational science from an industry executive's perspective, *Journal of Translational Science*. 2nd edn, 4.

Live Mint (2019). Of all scientific fields, medical research gets much less funding. (2019), Live Mint Retrieved October 3, 2019, from https://www.livemint.com/companies/people/ -of-all-scientific-fields-medical-research-gets-much-less-funding-1567016191472.html

Lund, K. (2012). Process management in R&D – Doom or salvation for creativity?, Licentiate thesis, KTH Royal Institute of Technology, Stockholm.

NCBS Newsletter, August 2018, https://www.ncbs.res.in/sites/default/files/users/malinisp/

August%202018%20newsletter_Final1_reduced.pdf

Nobelius, D. (2002). *Managing R&D Processes-Focusing on Technology Development, Product Development, and their Interplay.* Chalmers University of Technology, SE-412 96 Gothenburg, Sweden.

Portny, S. E. and Austin, J. (2002). Project management for scientists. American Association for the Advancement of Science, Washington, DC.

Reddy, P (1997). New trends in globalization of corporate R&D and implications for innovation capability in host countries: A survey from India, *World Development*, Volume 25, Issue 11, November 1997, Pages 1821-1837

Roy, S. and Nagpaul, P.S. (2001) Developing a measurement model of effectiveness of research units: problems and issues in quasi-quantitative measurement. In *Proceedings of the Conference on New Techniques and Technologies for Statistics: Exchange of Technology and Knowhow*, Hersonissos, Crete, Greece, 18 –22 June 2001. ISBN 92-894-1176-7, Joint Research Center-ISIS, European Commission and Eurostat, European Commission, pp. 333– 344

Szabo, R. and Csontos, R. (2016). Efficient Organization al Renewal: The Role of Technological and Management Innovation, *International Journal of Business Management & Research.* 6th edn, (3), pp. 35–50.

Un. Annique C. and Asakawa K. (2015). Types of R&D Collaborations and Process Innovation: The Benefit of Collaborating Upstream in the Knowledge Chain* *J Prod Innov Manag*;32(1):138–153, Product Development & Management Association DOI: 10.1111/jpim.12229"

Valluri. S.R. (1976). Priorities in R&D planning. Paper presented in the Seminar on Management of R&D Institutions. Bangalore.

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